# Technology Opportunity

## Alternative Applications For NASA Turbomachinery Hardware

The NASA Lewis Research Center has designed and tested turbomachinery for a wide range of operating conditions. These designs were primarily intended for application to the gas-turbine engine. However, by proper geometric and aerodynamic scaling, this existing hardware may be suitable for other applications. The time, effort, and cost of turbomachinery development can be significantly reduced.

### Potential Commercial Uses

- Turbine engines
- Turbochargers
- Compressors
- Vacuum systems
- Blowers and fans
- Air conditioning

### Benefits

- Saves the cost and effort of turbomachinery deveopment
- Uses existing turbomachinery designs with performance that has been verified experimentally

### The Technology

In order to scale an existing design to fit your application the following five-step procedure can be used:

(1) Assess the pressure ratio requirement and determine the flow and size constraints of your application.

(2) Select the existing design that satisfies your pressure ratio requirements from the table located on the back of this form. Note that this table cites a publication that contains the blade geometry and performance data from design and off-design operation.

(3) Scale the geometry using the geometric scaling factor defined by

$$\text{scale factor} = \left( \frac{\text{flow}_{\text{new}}}{\text{flow}_{\text{ref}}} \right)^{0.5}$$

Other parameters can then be determined:

$$\text{rpm}_{\text{new}} = \frac{\text{rpm}_{\text{ref}}}{\text{scale factor}}$$

$$\text{diameter}_{\text{new}} = \text{scale factor} \times \text{diameter}_{\text{ref}}$$

(4) Estimate the changes to efficiency that result from scaling. Refer to publications in the open literature which discuss this topic.

(5) Verify the structural integrity of the scaled geometry.

### Options for Commercialization

Compressors and turbines have been designed, manufactured, and tested. The geometry and performance data for these turbomachinery designs are available to those companies who want to use or scale the existing design for their turbomachinery application.

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## Key Words

Turbomachinery
Compressors
Turbines
Turbomachinery design
Geometric scaling

NASA Lewis Compressors

| Compressor | NASA reference | Rotational speed, rpm | Diameter, ft | Equivalent mass flow rate, lbm/sec | Overall total pressure ratio | Adiabatic efficiency, total to total |
|---|---|---|---|---|---|---|
| Axial (Rotor 67) | TP–2879 | 16 040 | 1.66 | 73.15 | 1.63 | 0.90 |
| Axial (Stage 35) | TP–1338 | 17 200 | 1.66 | 44.51 | 1.82 | .83 |
| Axial (Stage 37) | TP–1659 | 17 200 | 1.66 | 44.51 | 2.05 | .84 |
| Centrifugal (LLSC) | TP–3527 | 1 860 | 5.00 | 66.00 | 1.14 | .92 |
| Centrifugal (CC3) | Contract No. NAS3–23268 | 21 789 | 1.41 | 10.00 | 4.00 | .83 |
| 2-Stage axial (73D) | TP–1493 | 16 040 | 1.66 | 73.15 | 2.40 | .85 |
| 3-Stage axial (74A) | TP–2597 | 16 040 | 1.66 | 65.36 | 4.50 | .80 |

NASA Lewis Turbines

| Turbine | NASA reference | Equivalent mean blade speed, ft/sec | Equivalent specific work, Btu/lbm | Equivalent mass flow rate, lbm/sec | Overall total pressure ratio | Adiabatic efficiency, total to total |
|---|---|---|---|---|---|---|
| Single-stage high work turbine | TP–1680 | 652.4 | 33.01 | 8.18 | 3.44 | 0.89 |
| Single-stage high-temperature core turbine | TN D–7557 | 500.0 | 17.00 | 2.66 | 1.82 | .87 |
| Single-stage 75-kW power turbine | TMX–71714<br>TM–82644 | 549.9 | 15.08 | 1.38 | 1.71 | .85 |
| Compact radial turbine | TP–3514 | 975.6/R1<br>926.7/R2 | 41.75 | 2.35 | 5.00 | .88 |
| Cooled radial turbine | CR–179606<br>CR–189122<br>TM–106230 | 1223.7 | 59.61 | 4.00 | 4.05 | .87 |
| Variable nozzle radial turbine | CR–165397<br>CR–174663<br>CR–175091 | 1176.6 | 35.0 - 42.0 | 2.82 | 4.38 | .87 |
| Mixed-flow turbine | Contract No. NAS3–26063 | 1116.5 | 35.92 | .88 | 3.70 | .89 |

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